Before the
Federal Communications Commission
Washington, DC 20554

In the Matter of	)	
	)	
Wireless E911 Location Accuracy Requirements	)	PS Docket No. 07-114
	)	
	)	

To: The Commission

REPLY COMMENTS OF
THE BOULDER REGIONAL EMERGENCY TELEPHONE SERVICE AUTHORITY
ON VERTICAL (Z-AXIS) ACCURACY METRIC PROPOSED BY THE
NATIONWIDE WIRELESS CARRIERS

The Boulder Emergency Telephone Service Authority ("BRETSA"),[1] by its attorney, hereby submits it's Reply Comments on the Commission's March 15, 2019 Fourth Further Notice of Proposed Rulemaking in the above-captioned matter.

The Commission should require wireless providers to supply vertical location information with 9-1-1 calls, in all markets, at the earliest possible date. Any reduction in areas to be searched and time required to locate a caller (or person whose fall-detection device has triggered an alarm) will save lives. Accuracy and confidence data should be provided along with the vertical location information.

The Commission should adopt a vertical location accuracy standard of 2-meters in urbanized markets, and 3-meters in the rest of the country, which vertical location providers have demonstrated is achievable. Factors such as extremely cold temperatures, caller distance from

[1] BRETSA is a Colorado 9-1-1 Authority which establishes, collects and distributes the Colorado Emergency Telephone Surcharge to fund 9-1-1 Service in Boulder County, Colorado. The BRETSA Board includes the Boulder County Sheriff, the City of Boulder Police Chief, representatives of the Boulder County Firefighters Association and the City of Longmont Division of Public Safety. The fifth seat of the Board is filled by representatives of the smaller cities and towns in Boulder County, Colorado on a rotating basis. These Comments are thus intended to represent the perspective of the entity responsible for funding 9-1-1 operations, *and* of the agencies and authorities responsible for PSAP operations and overall public safety services.

reference barometric pressure sensors, quality of in-device barometric sensors, and time since calibration of sensors, if demonstrated to affect vertical location accuracy, are factors which will be used in calculating accuracy and confidence scores. Relevant sensor information must be transmitted by the device along with barometric pressure or elevation data.

Rather than relying solely upon test-bed performance and certification that a technology has been installed in a market consistent with test-bed installation; wireless providers should be required to complete prescribed proof-of-performance testing to determine and demonstrate the accuracy of vertical locations actually achieved. Not only have wireless providers argued that reasonable test-bed testing cannot reliably predict how the technologies will scale in a production environment, but accuracy of results will depend upon performance of multiple parties, and wireless providers have claimed it may also depend upon climactic conditions and the quality of barometric sensors and sensor calibration in wireless devices. Proofs-of-performance will also provide First Responders with an understanding of the accuracy of "fixes" they can expect in their jurisdictions, which will inform their Emergency Response and search protocols and procedures. Procedures for public safety agencies to conduct additional accuracy tests in their jurisdictions, and wireless provider cooperation in those tests, must also be provided so that First Responders can conduct additional accuracy tests they may find useful without the delay, or the cost to wireless providers, of relying on wireless providers to conduct such tests.

Correlating elevation AMSL returned by vertical location systems to floor level, based on the ground level AMSL at the building location and building design, will be a community effort likely to fall largely upon Fire Inspectors, Fire Agencies preparing, updating and maintaining pre-plans for significant buildings in their jurisdictions, and building owners pursuant to local land use ordinances which may be adopted. Public safety agencies should be able to recover their

costs of developing this information through charges for provision of data to entities which may have access to, and use, elevation data for commercial purposes, including wireless providers, wireless device manufacturers, and OS and App developers.

I. Google Raises Important Principles; But Some Of Its Recommendations Conflict With Those Principles.

Google succinctly and accurately states a key principle that:

> Every user that tries to contact 911, no matter what handset they use and how much it cost [*sic*], should be able to expect an equal level of protection for their life and safety. Thus, mobile operators should achieve the Commission's chosen z-axis metric for all handsets, as soon as possible.[2]

It is thus surprising that Google proposes that a less granular four-meter vertical location accuracy standard be adopted.[3] NextNav and Polaris have demonstrated they can meet a two-meter and three-meter standard.

Google also states:

> With lives and property, as well as potentially large penalties on the line, testing in which all stakeholders have confidence is imperative.[4]

No; with lives on the line, what is imperative is that the Commission adopt and implement the vertical location standards at the earliest possible time. Any reduction in the number of floors which must be searched for a caller will reduce the amount of time required to locate the victim.[5]

Despite the ability of First Responders to use the technology to locate a caller,[6] Google, wireless providers and others would delay adoption of a floor level vertical location standard until a technological solution is available which is ubiquitously capable of itself providing a floor

[2] Google Comments, at 11-12.
[3] Google Comments, at 9.
[4] Google Comments, at 13.
[5] It is also possible that First Responders could call 9-1-1 with their cell-phones. With the First Responder's vertical location determined by the same system used to determine the caller's location, PSAP dispatchers could guide the First Responders to the caller's floor level much more quickly than if First Responders have to search a number of floors in the building.
[6] See footnote 5, above.

level location. Notwithstanding quite consistent results in vertical location testing to date, Google joins in the arguments that additional testing is required to demonstrate equivalent location accuracy in extreme cold weather environments, rural morphologies (assuming there are rural morphologies in which it is economical to build skyscrapers), and across devices which may have different barometric sensor biases. However this would delay provision of lifesaving vertical location information in the majority of the country which is not subject to extremely cold-weather, and to those areas of the country which are subject to extremely cold weather during the times of the year that they are not subject to such weather.

BRETSA has also called for provision of accuracy and confidence data along with Z-axis data.[7] Providers have stated that extremely cold temperatures; rural-urban morphology; sensor manufacturer, model, and age or calibration date; and device manufacturer and model, are sources of error. Thus, these factors must be used in determining accuracy and confidence of a "fix." The Commission must require that such device and sensor data be transmitted with vertical location data for this purpose. Factors such as temperature and morphology should be available to providers in real time.

II. The Commission Should Require Nationwide Implementation Of Vertical Location Information By The Earliest Possible Date.

Inherent in the principle recognized by Google that every wireless user is entitled to equal protection of their life and safety, is the recognition that it is inequitable to phase-in vertical location accuracy requirements by geographic area. Nor is such a phase-in necessary.

Whatever the Commission's contemplation when it proposed the phase-in by market of vertical location information, there are multiple providers of vertical location information today.

[7] BRETSA Comments, at 9.

NextNav has repeatedly demonstrated over a period of years its highly accurate, compensated barometric pressure-based vertical location system, which requires that it place physical infrastructure in each market.[8] Polaris has demonstrated an accurate barometric pressure vertical location system, capable of using compensated barometric sensor information, which does not require infrastructure.[9] Google states that it can provide vertical location data through its Android 4.0/Ice Cream Sandwich or later OS, and proposes a 4-meter accuracy standard.[10] Vertical location information providers using compensated barometric pressure to determine elevation have demonstrated the ability to provide floor-level and near-floor level accuracy.[11]

In areas where highly accurate vertical location data using compensated barometric pressure information is available and supported by NextNav infrastructure, a 2- or 3- meter standard is appropriate. In areas where less accurate vertical location data is available, such as where less-granular reference barometric sensor information is available, a 3-meter standard appropriate.[12] Delivery of elevation data meeting these standards may be dependent upon market penetration of user devices with accurate and properly calibrated sensors. Provider-compliance with the adopted standards should be measured against compliant devices (device and sensor information must be provided to determine accuracy and confidence of the location data).

[8] NextNav has demonstrated that it can meet a sub 2-meter standard 80% of the time, both in the current tests and in CTIA's 2016 testing in which NextNav did *not* have an opportunity to calibrate the handset pressure sensors. Stage Z Report, at 120, 126-127.
[9] Polaris has submitted information that it can meet a 3-meter standard 80% of the time if permitted to use active sensor bias compensation in the test. Stage Z Report, at 133-134.
[10] Google Comments, at 1-3, 9-10.
[11] BRETSA has little confidence in technology to resolve the location of a user device to a specific street address and unit number based upon database of RF emitters, which may be located anywhere within a unit, which emissions are not constrained to the unit, and where insufficient data is available to calculate accuracy and confidence information, but which will nevertheless be presented to PSAPs as "the right door to kick-in."
[12] In rural areas where National Weather Service weather stations may be more sparsely located, the passage of pressure fronts and other localized changes in pressure may not be identified, preventing provision of more accurate location information.

III. Correlation Of Elevation Information To Floor Levels Will Require A Community Effort.

Several parties, including Google, have noted that elevation information (above AMSL), as provided by barometric sensors and other sources, will not necessarily correlate to the floor of a building on which a caller is located.[13] Elevation information derived from comparison of device-barometric sensor information with reference-barometric sensor information will necessarily be presented as elevation AMSL. The floor level of a caller within a multistory building will require knowledge of the ground level AMSL at the building's location, and the height of each floor in the building. Floor heights are not standard. The development and use of a massive, *accurate*, "floor-level database" for all multi-story buildings is not likely susceptible to implementation of reliable crowd-sourcing given the absence of reliable elevation reference information. Correlation of elevations AMSL to building floor levels will thus be a time-consuming process, which will likely fall upon local governments and public safety personnel. Buildings will likely be prioritized for correlation of elevation data to floor levels starting with the tallest buildings, where the greatest benefit will be realized. In the near-term, public safety agencies with many tall buildings in their jurisdictions may focus on determination of ground level AMSL at the designated first floor of a building, and designate an "average" floor or story height for PSAPs and First Responders to use in converting an elevation AMSL to a usable estimate of the floor number on which to begin searching for callers to 9-1-1.

Most local building departments maintain copies of applications for building permits, including building plans. Such records may serve as a source of floor level elevation data.

In most jurisdictions, Fire Agencies not only conduct inspections of more significant structures, but they also prepare "pre-plans" for such structures. Pre-plans are based on building

[13] Google Comments, at 11.

floor plans, with information not relevant to emergency response removed, and information such as location of exterior valves for tankers to boost sprinkler systems, points of entry and elevator keys indicated. Locations for staging and positioning of fire apparatus are also indicated. Correlation of elevation data to floor levels of buildings for which Fire Agencies develop and maintain pre-plans may be accomplished through the development, review and updating of such pre-plans, and fire inspections.[14] These may be the preferable means of correlating elevation information to floor levels, since Fire Agencies will already have or be developing the pre-plans based on accurate floor plans, periodically inspect the buildings, and have a closer association with PSAPs to provide floor elevation data for inclusion in CAD premises files.

Local governments might also, or alternatively, adopt ordinances requiring owners of multi-story building to file, update when changed, and periodically verify ground and floor-level elevation information.

Wireless providers also design and install roof-top and in-building CMRS antennas to assure adequate service and capacity for building tenants and visitors. When installing or maintaining cell-sites, CMRS personnel should be in a position to document ground level AMSL and floor-level elevations .

To the extent local governments and First Responder agencies compile floor-level elevation data which will also be of value to commercial services providers, the sale of such data to commercial services providers may offset the costs of compiling the data.[15]

[14] Determination of ground level AMSL may pose the greatest challenge.

[15] The reason Google and other potential location providers are willing to provide vertical location data for 9-1-1 calls at no charge is likely that there are other commercial uses and/or revenue sources from development and provision of such data to internal or external consumers of the data. There may be privacy and Constitutional considerations which warrant limiting use of location data provided PSAPs to emergency response, absent warrant. However the Commission should not interfere with commercial location services markets which support third party provision of location data for 9-1-1 call purposes at no charge, and which are provided with consumer consent.

IV. Enforcement Of Vertical Location Standards Must Take Into Account Third-Party Provision Of Vertical Location Data.

Whatever the Commission's prior expectations for wireless provider compliance with vertical location standards, it is clear that the availability and accuracy of vertical location data will depend upon third-party solutions and compliance, particularly since viability of the NEAD has been drawn into question by limited contributions to the database and the disappointing results of NEAD tests. Insofar as barometric pressure is used to determine vertical locations, it will depend upon third-party vertical location providers and proper installation and calibration of barometric sensors in user devices, not fully within the control of wireless providers.

BRETSA thus proposes a multi-faceted vertical location standard approval and enforcement process. That is, test-bed testing should be required to demonstrate that a location technology *is capable* of meeting the location standard adopted by the Commission.[16] Whether a specific technology will meet the standard at scale cannot be reliably determined until the technology is deployed at scale, and will not be solely within the control of the wireless provider.[17]

Wireless providers should be required to conduct initial and periodic proof-of-performance testing using a Commission-prescribed methodology. The proofs-of-performance will identify the actual performance of location technologies both as implemented by wireless providers, and by third-party providers necessary to determination and delivery of elevation data

[16] BRETSA believes NextNav has demonstrated it can meet a 2-meter vertical location standard in markets in which its infrastructure has been deployed, Polaris is capable of meeting a 3-meter location standard with *compensated* barometric data, without infrastructure deployment; and that current capabilities of vertical location technologies can substantially reduce the area within a multi-story building to be searched for a caller, and the search time. Where there are alternative location technologies available, the most accurate location data should be provided PSAPs.

[17] While repeated testing may give confidence that a technology will meet the standard at scale; the cost of repeated testing without approval is a deterrent to location provider participation in such testing and will delay the availability of the life-saving reduction in search areas and times discussed above. Even if a technology will not meet a two- or three- meter standard at scale, it is still likely to substantially reduce search areas and times and save lives.

to PSAPs with accuracy and confidence scores. This will allow providers and the Commission to assess the performance of the various parties involved in vertical location determination for compliance purposes, remedial action to improve accuracy, and replacement of less-accurate location sources with more-accurate sources. Location data affected by weather conditions, device sensor issues, and other factors affecting accuracy and confidence scores which are not within the control of the wireless service provider should be excluded from calculation of the percentage of calls for which vertical location information meets the Commission standard. Thus, providers should be held to *achievable* standards *within their control*.

End-to-end proofs-of-performance will also identify weaknesses in location determination. Solutions for barometric pressure-based systems might involve automated or user-initiated sensor calibration, improvements in location processing, deployment of additional reference sensors, or adjustments to compensate for extreme cold weather or other factors proven to affect accuracy. The most accurate location data should be provided PSAPs, and periodic proofs of performance should allow wireless providers and the Commission to identify technologies and location providers consistently providing more- or less- accurate location data.

Proofs-of-performance, and publication of methodology for public safety agency testing of location accuracy within their jurisdictions (with cooperation of wireless providers, as necessary) will allow agencies to adapt their emergency response and premises search protocols and procedures to the level of accuracy of vertical location data they can expect to receive.[18]

[18] The minimum cooperation of wireless providers which might be required by local public safety authorities is (i) development and publication of an adequate yet efficient and cost effective test procedure (*e.g.*, permitting a single First Responder on light duty due to an injury, or volunteer, for example, to conduct and complete tests), (ii) the establishment of an alternative number to "9-1-1" to be called for test purposes to avoid tying up 9-1-1 lines and PSAP personnel with such test calls, (iii) a user-code for the agency conducting the tests, (iv) the ability to enter a test-reference code to assist in correlating test results with a particular test, and (v) a web interface for accessing test results and entering user specified data such as the actual location from which a test call was made. This same cooperation should permit testing of the resolution and accuracy of x,y coordinates or dispatchable locations provided with 9-1-1 calls.

V. Proofs-Of-Performance Are Required To Verify Z-Axis Technologies Are Consistently Deployed In Test Bed And Production Environments.

CTIA argues that demonstration of compliance of a vertical location technology with the standard adopted by the Commission in the Test Bed is sufficient. A wireless provider need only certify that the z-axis technology is deployed in a market consistently with how it was tested in the Test Bed to demonstrate that it complies with the standard *as deployed*. Thus, CTIA proposes that the language "as measured in the test bed" be added at the end of the proposed Sections 20.18(i)(2)(ii)(C)&(D).

Whatever the Commission initially anticipated, it appears vertical location information will depend upon consistent use and calibration of quality sensors by device manufacturers, possibly proper coding of device firmware and software, and consistent processing of sensor data by location technology providers. Thus, it is not just the wireless provider which must deploy the vertical location technology consistent with test-bed deployment to obtain consistent results.

The proof-of-performance methodology prescribed by the Commission should permit confirmation that vertical location accuracy provided in a production environment is consistent with the level of accuracy achieved in the test bed, at reasonable cost to wireless providers.

Respectfully submitted,

BOULDER REGIONAL EMERGENCY TELEPHONE SERVICE AUTHORITY

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